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GB 1229719
GB 1225421
GB 911008
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(71) Applicants
Sony Corporation, 7—35
Kitashinagawa-6,
Shinagawa-ku, Tokyo,
Japan
(72) Inventor
Tadao Yoshida
(74) Agents
D. Young & Co.

(54) **Inverter circuits**

(57) A freerunning inverter circuit includes a *dc* voltage source 1 having first and second terminals, an input transformer 6 having a primary winding 6*c*, a pair of secondary windings 6*a* and 6*b* and a magnetic core, an output transformer 3 having a primary winding 3*a*, a secondary winding 3*b* and a feedback winding 3*c*, first and second transistors 4 and 5 each having a control electrode, the main current paths of which are connected, through the primary winding 3*a* of the output transformer 3, between the terminals of the voltage source 1 and the control electrodes of which are connected to the pair of secondary windings 6*a* and 6*b* of the input transformers 6, a coupling circuit for connecting the primary winding 6*c* of the input transformer 6 to the feedback winding 3*c* of the output transformer 3, a start circuit 9 for putting one of the first and second transistors 4 or 5 in the conductive state when the voltage source 1 is operated, and a control circuit 10 to 15 including a short-circuiting winding 15 associated with the magnetic core of the input transformer 6 so as to cut off the first and second transistors 4 and 5 when the voltage source 1 via a switch 10 is switched off. The output circuit 3 may be a half bridge type (Fig. 3).

FIG. 2

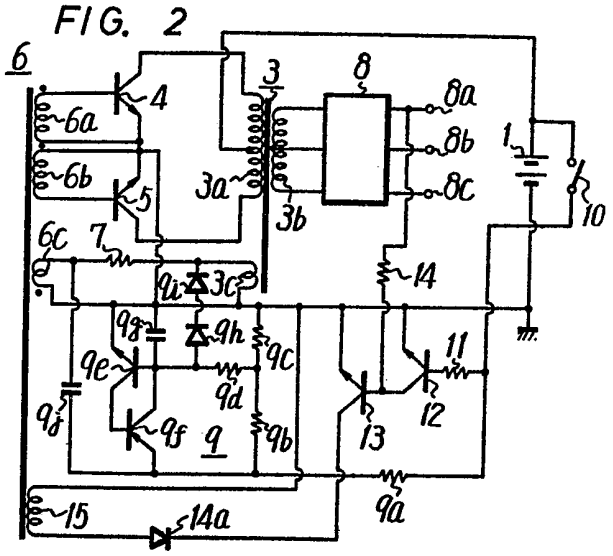

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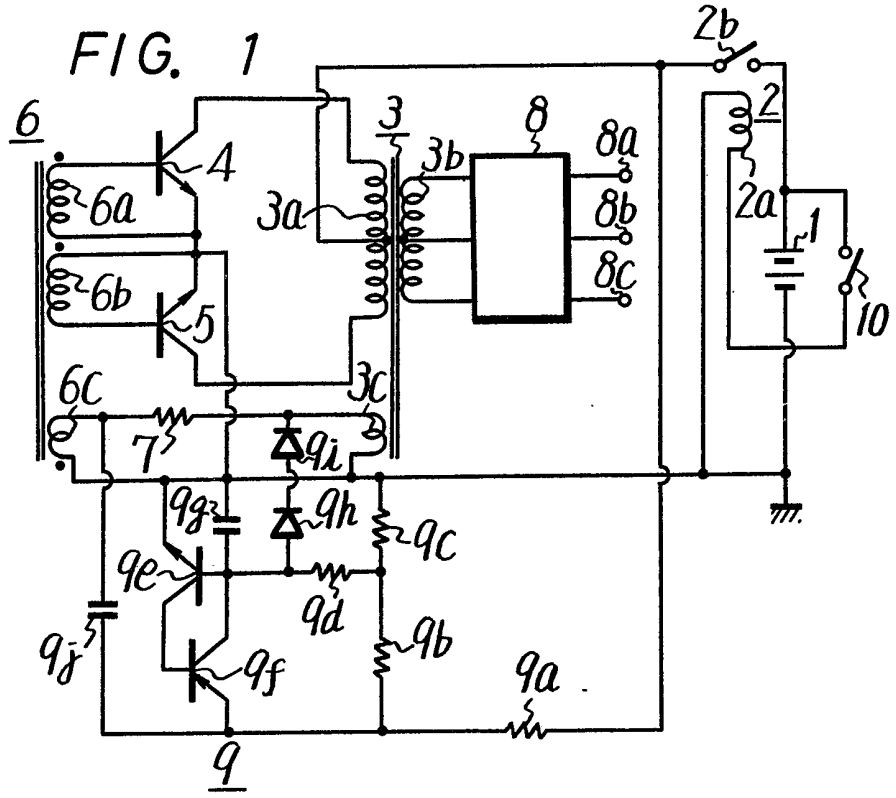
FIG. 1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6
3
8
8a
8b
8c
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2a
1
10
4
3b
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6b
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6c
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qi
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qe
qd
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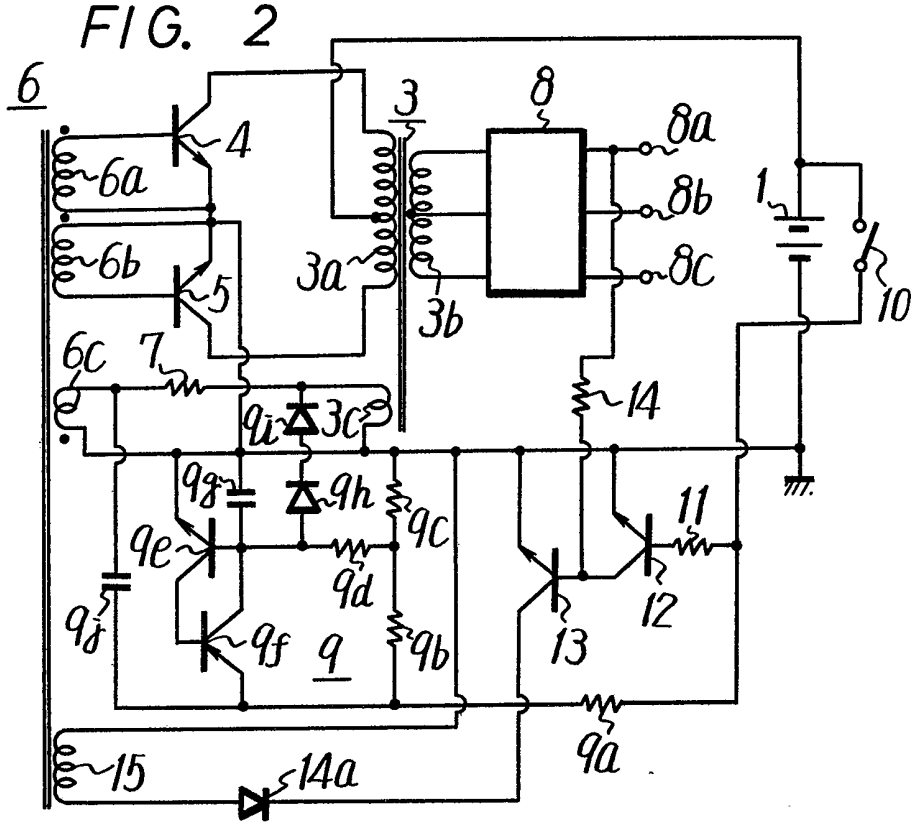
qj
qf
qa
q

FIG. 2


6
3
8
8a
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8c
1
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6a
6b
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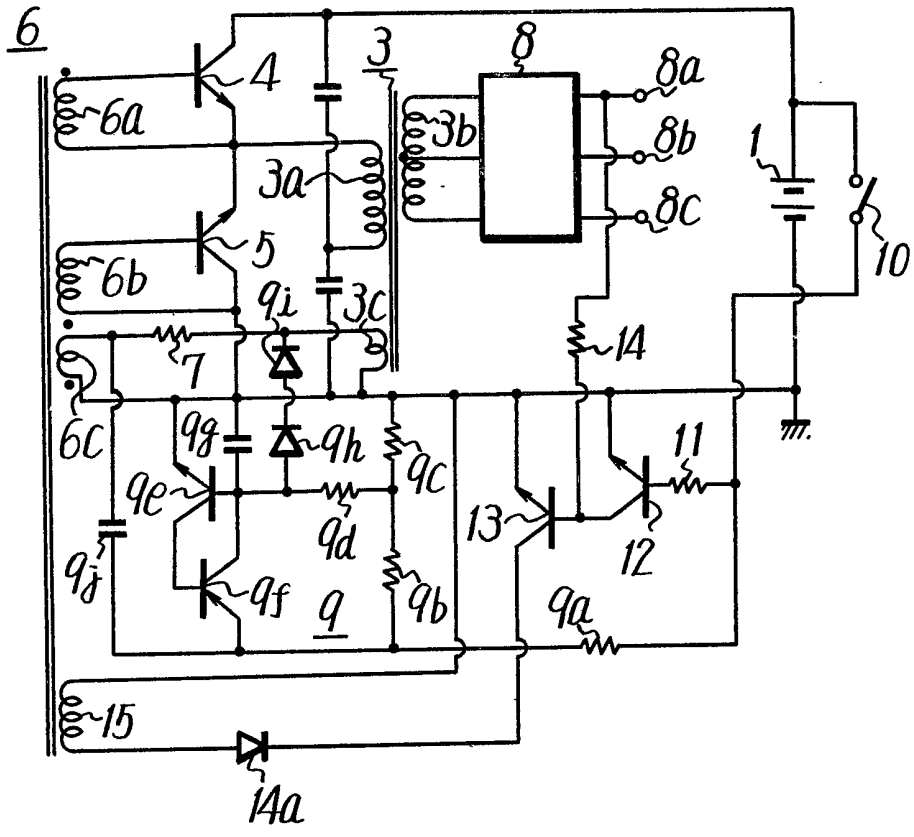
3a
3b
6c
7
14
qi
3c
qg
qh
qc
11
qe
qd
12
qj
qf
q
qb
13
9a
15
14a

FIG. 3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3
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8a
6a
3b
8b
1
3a
8c
5
10
6b
qi
3c
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7
6C
qg
qh
qc
11
qe
qd
13
12
qj
qf
q
qb
qa
15
14a

SPECIFICATION
Inverter circuits

This invention relates to inverter circuits.

According to the present invention there is provided an inverter circuit comprising:

first and second *dc* voltage source terminals;

an input transformer having a primary winding, a pair of secondary windings and a magnetic core;

an output transformer having a primary winding, a secondary winding and a feedback winding;

first and second transistors each having a control electrode, the main current paths of which are connected, through the primary winding of said output transformer, between said first and second terminals, and the control electrodes of which are connected to the pair of secondary windings of said input transformer;

circuit means for connecting the primary winding of said input transformer to the feedback winding of said output transformer;

a starting circuit for putting one of said first and second tranistors in its conductive state when said *dc* voltage source is operated; and

a control circuit including a short-circuiting winding provided associated with the magnetic core of said input transformer so as to cut off said first and second transistors when said *dc* voltage source is not operated.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like references designate like elements, and in which:

Figure 1 is a circuit diagram of a prior art inverter circuit; and

Figure 2 and 3 are circuit diagrams of respective embodiments of inverter circuit according to the invention.

Before describing the embodiments, a prior art inverter circuit will be described with reference to Figure 1, which shows an inverter circuit for use with a car stereo, and which utilizes a *dc* voltage from a car battery and the power from which is switched ON and OFF by an external control signal.

In Figure 1, a car battery 1 has the positive electrode connected through a relay switch 2*b* of a relay 2, which will be described later, to a mid-point of a primary winding 3*a* of an output transformer 3. One end of the primary winding 3*a* is connected to the collector of an NPN type transistor 4 serving as a switching element and the other end of the primary winding 3*a* is connected to the collector of another NPN type transistor 5 serving as a switching element whose emitter is connected to the emitter of the transistor 4. The connection point of the emitters of the transistors 4 and 5 is connected to the negative electrode of the battery 1 which is grounded. An input transformer 6 is provided whose control windings 6*a* and 6*b* are connected between the bases and emitters of the transistors 4 and 5, respectively, in such a manner that the winding direction of the control windings 6*a* and 6*b* are opposite. The output transformer 3 has a feedback winding 3*c* one end of which is connected through a resistor 7 to one end of a voltage feedback winding 6*c* of the input transformer 6, and the other ends of the respective feedback windings 3*c* and 6*c* are connected together to ground. The *dc* voltage induced across a secondary winding 3*b* of the output transformer 3 is supplied to a rectifier circuit 8 which produces a *dc* voltage with a predetermined positive value between its output terminals 8*a* and 8*b* and a *dc* voltage with predetermined negative value between its output terminals 8*c* and 8*b*.

The connection point between the relay switch 2*b* and the primary winding 3*a* of the output transformer 3 is grounded through a series circuit comprising three resistors 9*a*, 9*b* and 9*c* which form a part of a starter circuit 9. The connection point between the resistors 9*b* and 9*c* is connected through a resistor 9*d* to the base of an NPN type transistor 9*e*, and the connection point between the resistors 9*a* and 9*b* is connected to the emitter of a PNP type transistor 9*f* whose base is connected to the collector of the transistor 9*e* and whose collector is connected to the base of the transistor 9*e*. The base of the transistor 9*e* is in turn grounded through a capacitor 9*g* and is also connected through a series connection of two diodes 9*h* and 9*i* to one end of the feedback winding 3c of the output transformer 3. The emitter of the transistor 9*f* is connected through a capacitor 9*j* to one end of the voltage feedback winding 6*c* of the input transformer 6. The positive electrode of the battery 1 is grounded through a series connection of a switch 10, which is made ON when, for example, a cassette tape is loaded into a car stereo, and a relay winding 2*a* of the relay 2.

The operation of the above prior art circuit will now be described. When the cassette is loaded into the car stereo, the switch 10 is made ON and the output voltage from the battery 1 is supplied to the relay winding 2*a*. Thus, the relay switch 2*b* is made ON. Accordingly, the output voltage from the battery 1 is supplied through the relay switch 2*b* and the resistor 9*a* to the capacitor 9*j* of the starter circuit 9 and hence the capacitor 9*j* is charged up to a predetermined voltage. The output voltage from the battery 1 is divided by the resistors 9*a* and 9*c* and then supplied through the resistor 9*d* to the capacitor 9*g* to charge it. Thus, the base voltage of the transistor 9*e* in the starter circuit 9 increases gradually in response to the time constant determined by the resistor 9*d* and the capacitor 9*g*, so that the transistor 9*e* is made ON after a predetermined time from the time when the relay switch 2*b* becomes ON. When the transistor 9*e* becomes ON, the base-emitter junction of the transistor 9*f* is forwardly biased and hence the transistor 9*f* turns ON. Accordingly, the charge in the capacitor 9*j* is discharged through the transistors 9*f* and 9*e* and the voltage feedback winding 6*c* to generate a start pulse across the voltage feedback winding 6*c*. Thus, one

of the switching transistors 4 and 5 in made ON by the start pulse, so that the inverter comprising the transistors 4 and 5 and the transformers 3 and 6 starts operation.

After the inverter has started, the switching transistors 4 and 5 become ON and OFF alternately. Thus, a pulse signal is generated across the secondary winding 3*b* of the output transformer, and accordingly a positive *dc* voltage and a negative *dc* voltage are produced between the output terminals 8*a* and 8*b* and between the output terminals 8*c* nd 8*b* of the rectifier circuit 8, respectively. After the inverter has started, the base of the transistor 9*e* is supplied with the pulse signal from the feedback winding 3*c* through the diodes 9*i* and 9*h* as a reverse bias, so that the transistors 9*e* and 9*f* become OFF. Accordingly, the power consumed in the starter circuit is reduced.

When the cassette is withdrawn from the car stero, the switch 10 is made OFF. As a result, the relay winding 2*a* is de-energized and hence the relay switch 2*b* turns OFF. Thus, the inverter circuit becomes inoperative.

With the above prior art inverter circuit, the relay 2 is employed to make the power source ON and OFF, so that power is additionally consumed in the relay 2. When the normal power of the inverter circuit increases, a relay of large size becomes necessary with the result that the relay consumes substantial power and the circuit becomes expensive.

In the embodiment of the invention shown in Figure 2, the positive electrode of the battery 1 is connected to the mid-point of the primary winding 3*a* of the output transformer 3 and also to ground through the series connection comprising the switch 10, which is made ON when a cassette is loaded into a car stereo, and the resistors 9*a*, 9*b* and 9*c*. The connection point between the switch 10 and the resistor 9*a* is connected through a resistor 11 to the base of an NPN type transistor 12 whose emitter is grounded and whose collector is connected to the base of an NPN transistor 13 and also the output terminal 8*a* of the rectifier circuit 8 through a resistor 14 with relatively high resistance value. The transistor 13 has the emitter connected to ground and the collector connected to the cathode of a reverse current blocking diode 14*a* whose anode is grounded through a short-circuiting winding 15 wound on the core of the input transformer 6. The number of turns of the short-circuiting winding 15 is relatively large compared with those of the control windings 6*a* and 6*b*. The other circuit construction of the embodiment of Figure 2 is substantially the same as that of the circuit of Figure 1.

The operation of the embodiment of Figure 2 will now be described. When a cassette is loaded into the car stereo, the insertion of the cassette is detected and the switch 10 is closed. Then, the control signal, that is a *dc* voltage from the battery 1 is applied to the series connection of the resistors 9*a*, 9*b* and 9*c*, and the capacitor 9*j* is charged by the voltage from the battery 1, through the resistor 9*a*. At the same time, as in the circuit of Figure 1, the transistors 9*e* and 9*f* are operated to supply the start pulse to the voltage feedback winding 6*c* thereby to make the transistors 4 and 5 operative. Thus, the inverter comprising the output transformer 3, the transistors 4 and 5 and the input transformer 6 starts oscillating. As the *dc* voltage from the battery 1 is supplied through the resistor 11 to the base of the transistor 12, the transistor 12 becomes conductive to make the base potential of the transistor 13 the same as its emitter potential and equal to ground level. As a result, the transistor 13 becomes non-conductive, so that the short-circuiting winding 15 is opened. Therefore, after the inverter has started, its oscillation state is maintained, with the result that between the output terminals 8*a* and 8*b* and between the output terminals 8*c* and 8*b* there respectively appear desired positive and negative *dc* voltages, and hence the power source for the car stereo is made operative. Moreover, when the inverter is made to oscillate as in the circuit of Figure 1, a base voltage Vb of the transistor 9*e* is supplied through the diodes 9*h* and 9*i* to one end of the feedback winding 3*c* of the output transformer 3, and the transistor 9*e* is reversely biased by the *ac* voltage generated from the feedback winding 3*c*. Thus, the starter circuit 9 becomes inoperative.

When the cassette is taken out of the car stereo, the switch 10 turns OFF and hence the control signal, that is the *dc* voltage from the battery 1 is not applied to the base of the transistor 12, with the result that the transistor 12 turns OFF. Accordingly, the positive *dc* voltage obtained at the output terminal 8*a* is applied through the resistor 14 to the base of the transistor 13, so that the transistor 13 turns ON and hence the short-circuiting winding 15 is short-circuited therethrough. Thus, the positive feedback signal from the voltage feedback winding 6*c* to the control windings 6*a* and 6*b* is short-circuited by the short-circuit winding 15 thereby to stop the oscillation of the inverter. As a result, the positive and negative *dc* voltages between the output terminals 8*a* and 8*b* and between the output terminals 8*c* and 8*b* are no longer produced.

As described above, the inverter circuit can be made ON and OFF by the control signal through the switch 10, so the prior art relay 2, which makes the *dc* voltage supply line from the battery 1 ON and OFF directly, is not used. Therefore, the power consumed can be reduced.

Figure 3 shows another embodiment of the invention, in which, in place of the inverter of push-pull circuit construction used in the embodiment of Figure 2, an inverter of half-bridge circuit construction using switching transistors of the same polarity is used.

In the respective embodiments described, the *dc* voltage developed at the output terminal 8*a* is supplied to the base of the transistor 13 through

the resistor 14, but the *ac* voltage generated across the feedback winding 3*c* can be supplied through a rectifier circuit and a resistor instead with the same effect.

CLAIMS

1. An inverter circuit comprising:

first and second *dc* voltage source terminals;

an input transformer having a primary winding, a pair of secondary windings and a magnetic core;

an output transformer having a primary winding, a secondary winding and a feedback winding;

first and second transistors each having a control electrode, the main current paths of which are connected, through the primary winding of said output transformer, between said first and second terminals, and the control electrodes of which are connected to the pair of secondary windings of said input transformer;

circuit means for connecting the primary winding of said input transformer to the feedback winding of said output transformer;

a starting circuit for putting one of said first and second transistors in its conductive state when said *dc* voltage source is operated; and

a control circuit including a short-circuit winding provided associated with the magnetic core of said input transformer so as to cut off said first and second transistors when said *dc* voltage source is not operated.

2. An inverter circuit according to claim 1 wherein said control circuit further includes an ON-OFF switch having a pair of terminals one of which is connected to said first terminal, and switching means connected to said ON-OFF switch to short-circuit and short-circuit winding during ON operation of said ON-OFF switch.

3. An inverter circuit according to claim 2 wherein said switch means comprises a normally conductive third transistor having a base, emitter and collector, the base of which is connected to said other terminal of said ON-OFF switch and the emitter of which is connected to said second terminal, a fourth transistor having a base, emitter and collector, the base of which is connnected to the collector of said third transistor, the emitter and collector of which are connected across said short-circuit winding of said control circuit means and circuit means for supplying a rectified output signal of said secondary winding of said output transformer to the base of said fourth transistor to cause it to conduct.

4. An inverter circuit according to claim 3 wherein said third and fourth transistors are of the same conductivity type.

5. An inverter circuit according to claim 4 further comprising a diode connected in series with said short-circuit winding and the collector-emitter circuit of said fourth transistor to prevent a reverse current.

6. An inverter circuit according to claim 5 wherein said first and second transistors are of complementary conductivity type.

7. An inverter circuit according to claim 6 wherein said first and second transistors are of the same conductivity type.

8. An inverter circuit substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

9. An inverter circuit substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

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